ARDiary: A Life Record System With Augmented Content and Physical Interactions

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Abstract

Diary writing is a habit of many people to record life. Traditional paper diary has a series of problems, such as the content is difficult to modify and lack of interaction. Digital diary can solve these problems and store more content, but it lacks the comfortable physical interaction of paper. These years, the development of mixed reality techniques provides more possibilities for providing tangible interactions.

In this paper, we propose a diary writing and reading system that combines augmented reality with physical interactions. The system allows users to write digital diary content on their mobile phones, and provides a paper book with AR marker, which enables users to read diary content through AR glasses and feel the physical interaction of paper books.

Our system mainly has two functions: diary writing and diary reading. The first is the diary writing function. Users use their mobile phones to write the diary. The contents of the diary are can be text, pictures, audio, videos and also 3D Models. Users can also add life log data from their smartphone, such as the date, number of steps and visited location. After writing, the contents of the diary will be stored and bound to an AR marker.

The second function is the diary reading function. The system has a physical book with AR markers. When the content of a page diary is completed, it will be stored and associated with an AR marker. Users can read the contents of the diary with AR glasses, and they can also use gestures to interact with models and video playback.

Keywords: augmented reality, tangible interaction, diary writing

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Then I want to thank my parents. Thank you for giving me financial support and encouragements throughout my school life. I am appreciated to have your warm accompany all the time.

Finally I would like to thank my friends who play games with me every time. Without your company, I might have given up at this loneliest time.

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Chapter 1

Introduction

1.1 Introduction

With the development of technology, many physical interactions have been replaced by digital interactions[1]. For example, people now use mobile phones, e-books and other digital products more for reading, instead of traditional paper books and newspapers. However, these digital experiences lack some realistic physical experiences, such as the feeling of turning pages, moving, and holding books.

A number of studies have proven that users attach importance to this kind of physical interaction. For example, people think that they have a deeper sense of participation when reading physical books[2]. Most scientists prefer to print out research papers[3]. People find that holding a physical photo album is a more authentic and intimate experience when flipping through the pages of the book[4].

Now augmented reality (AR) technology provides more and more possibilities to different kinds of applications[5]. And using augmented reality (AR) to overlay physical objects with digital content can be a solution to combine physical interaction with digital content.

Currently, some researches have proposed augmenting digital content onto books and other objects. We address the specific question of reading and writing the diary when the content is overlaid on the corresponding physical object. In addition to combining the reading and writing of the diary with physical interaction, we also studied how to give users a better

user experience in the process of reading and writing the diary. In this case, users can customize the augmented reality content instead of only displaying fixed content.

In this research, we designed a diary writing and reading system with augmented content and physical interactions. The user is able to write the diary from the smartphone and read the diary from HMD devices. In the system, different types of diary content, such as text, pictures, video, audio and 3D models can be read and written.

We implement a new interactive method for reading diary, which combines the point-and-click interaction of electronic content, gesture interaction in mixed reality, and physical interaction with paper books. We also implement some methods to help people write the diary easily, such as adding life-log data from the smartphone. Then we implement a method to restore the diary layout of the smartphone application with the augmented content in the HoloLens application.

1.2 Organization of the thesis

The rest of the thesis is organized as follows: In chapter 2, we will introduce the background of the thesis. In chapter 3, we will introduce some related works. In chapter 4, we will describe the goal and approach of our research. In chapter 5, we will introduce the concept of the system design. In chapter 6, we will show the implementation details for the system development. In chapter 7, we will make a conclusion and talk about future possibilities.

Chapter 2

Background

2.1 Marker Based Augmented Reality

Augmented Reality(AR) is a real-time direct or indirect view of a physical real-world environment that has been enhanced / augmented by adding virtual computer-generated information to it[6].

AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it[7].

There are two types of simple augmented reality: marker based which uses cameras and visual cues, and marker less which use positional data such as a mobile's GPS and compass[8].

Type	Characteristics
Marker based AR	AR triggered by a visual marker.
Marker less AR	AR triggered by positional data.

Table 2.1 Types of Augmented Reality

As for the maker based AR, different types of AR markers are images that can be detected by cameras and used together with software as virtual asset locations placed in the scene.

Most are black and white, but colors can also be used as long as the contrast between them can be correctly recognized by the camera. Simple augmented reality markers can consist of one or more basic shapes made up of black squares on a white background. More complex tags can be created using simple images that can still be read correctly by the camera, and the code can even take the form of tattoos.[9]

2.2 Tangible Interaction

Tangible interaction includes the user interface and interaction methods. Tangible user interface (TUI) is a user interface in which a person interacts with digital information through the physical environment. Together with some interactive methods, it forms the tangible interaction.

In the early days, people used more tangible interactions. For example, people will be accustomed to reading paper books, paper documents, and interacting with some tangible objects. However, with the development of technology and the rise of digital content, this digital interaction has gradually replaced some tangible interactions. For example, people use mobile phones or e-books more for reading[10].

Under the prevalence of digital interactions, tangible interactions are also important, and the experience they can bring to users is different. There are many applications that combine tangible and digital interactions together.[11]

2.3 Diary Writing

Keeping a diary is a good way to record life. Now many people has the habit of keeping a diary[12]. There are two kinds of diaries, one is paper diary and the other is electronic diary.

As for the paper diary. It has the comfortable physical interaction. However, the content of the diary is simple and limited. Also the content is difficult to modify after finishing the diary page[13].

Digital diary is more popular now. There are lots of digital diary writing applications. In addition, there are life recording platforms such as blogs[14]. Compared with the paper diary, the content of the electronic diary can be richer, for example, some video, audio and other media files can be put into it. And users can change its content more easily. However, digital diaries lack the physical interaction of paper diaries. This makes the user lack the real feeling and comfort of contact with the paper when using it.

Now, some wearable devices has the function to record users' life-log data. A life-log is a personal record of one's daily life in a varying amount of detail, for a variety of purposes. The record contains a comprehensive data set of a human's activities. The data could be used to increase knowledge about how people live their lives.[15]. Some diary writing applications has the function to read and use the user's life-log data automatically. It is a convenient way to help users write the diary.

Chapter 3

Related Work

3.1 Augmenting Information on Physical Objects

Augmenting Information on physical objects is a good way to use augmented reality to add more information on the real world. There are several apps and demos that augment content on the physical objects.

The MagicBook[16] a Mixed Reality interface that uses a real book to seamlessly transport users between Reality and Virtuality. A vision-based tracking method is used to overlay virtual models on real book pages, creating an Augmented Reality scene. When users see an AR scene they are interested in they can fly inside it and experience it as an immersive Virtual Reality (VR). The interface also supports multi-scale collaboration, allowing multiple users to experience the same virtual environment either from an egocentric or an exocentric perspective.

Lindlbauer et al.[17] change physical object appearance such as enlarging a book by augmenting the space around. Many real-world objects cannot easily be equipped with displays or actuators in order to change their shape. However, using augmented reality and augmenting Information on them is a solution. They can enlarge a book to make it conspicuous or change the contour of a wallet to notify users when their bank account is debited.

Gupta et al. [18] investigate the interaction design for such digital-overlaid physical objects and their varying levels of tangibility. They first conduct a user evaluation of a physical photo album that uses tangible interactions to support physical and digital operations. They further prototype multiple objects including bookshelves and newspapers and probe users on their usage, capabilities, and interactions.

In summary, these studies have used augmented reality, adding information to physical objects. This makes the information richer and the interaction is better.

However, these work has some shortcomings. The first is that the content of augmented reality is fixed. In Lindlbauer's work, how to display in the environment is set in advance. In Gupta's augmented album prototype, they can only interact with the physical book. The content on the album is also fixed. In many cases, the content we read needs to be customized or modified, such as when the user reads and writes the diary. In this case, the content of these related work has limitations.

The second shortcoming is that there is little interaction between users and augmented content. In Gupta's augmented album prototype, the augmented content is just fixed photos. So there are only some physical interactions with the album. If there are more kinds of interactions, it will be better.

3.2 Diary Writing

Many people now have the habit of writing diaries, especially digital diaries. And now there are many studies and applications aimed at improving the user experience of writing diaries.

Some applications can analyze the content of the diary and give feedback to users. Introspective Journal[19] is a digital diary for self-realization. It allows the user to identify patterns in their behaviors, emotions, and traumas. The application allows the user to tag their experiences by emotions, people, morals, mental illnesses, etc. These tags can later be used to provide analytical insight that helps the user to understand themselves better.

Life-log is an important information for recording life, so it can be widely used in diaries. Some research focuses on reading the life-log data in the device and applying it to the writing of the diary. Park et al.[20] propose a digital diary making system which aimed at measuring the user emotion from their life-log data (daily-life photos). They get those life-log data from user's smartphone storage. The final product of digital diary includes feeling, time, and physical location information.

In summary, these researches focus on how to improve the user experience when writing digital diaries. There are several methods to help people write the diary. However, digital diaries lack the physical interactions. If there is physical interactions with good writing experience, it would be a method to provide diary users with better experience.

3.3 Tangible Augmented Reality

Tangible AR (TAR)[21] is when each augmented virtual object is mapped to a physical object, the user can interact with virtual objects by manipulating physical objects.

Tangible Augmented Reality is often used in the educational field. Augmented Chemistry[22] is an interactive educational workbench. M. Fjeld et al. report on some of the advantages tangible interaction can bring to chemistry education. They describe the realisation of a tangible user interface (TUI) called Augmented Chemistry (AC). A set of interactive tools work within this system. Using these tools, elements can be chosen from a booklet menu and composed into 3D molecular models.

Shim et al.[23] propose an augmented reality content authoring system that enables ordinary users who do not have programming capabilities to easily apply interactive features to virtual objects on a marker via gestures. They use AR markers to show 3D models and use their gesture to control them.

Further, Holman et al.[24] proposed tangible paper actions including collating, folding, stapling, etc. and showed their effects on web pages projected onto paper.

In summary, Tangible Augmented Reality is now used in different field. There is no doubt that TAR is a way to combine augmented reality and the real world. If it can be applied reasonably, it can bring a better experience to users.

Chapter 4

Research Goal and Approach

4.1 Research Goal

The goal of our research is to design an interaction way that combines augmented reality and physical interaction to solve the problem of writing and reading diaries and improve the user experience of writing and reading diaries. Our goal can be divided into the following points:

1. Design a diary reading and writing system that combines augmented reality and physical interaction.
2. Design and realize the interaction way of reading diary to enable users to have a better experience when interacting with the physical diary book.
3. Design and implement some methods to help people write the diary easily.

4.2 Approach

To achieve our goal, we divided our work into three parts.

1. First is using a physical book with AR markers on each page. The physics book contains physical interaction, and the AR markers inside are the bridge between augmented reality and the real world. In this way, the first goal can be achieved.

2. The second part is designing and implementing the HoloLens application. It includes basic functions such as displaying augmented content, gesture interaction with diary content, and physical interaction with the book itself. In this way, the second goal can be achieved.

3. The third part is designing and implementing the smartphone application. It allows users to edit the content of the diary, including text, pictures, video, audio and 3D models. In addition, it can read some life-log data in the phone, and then automatically add it to the diary, thereby achieving the third goal.

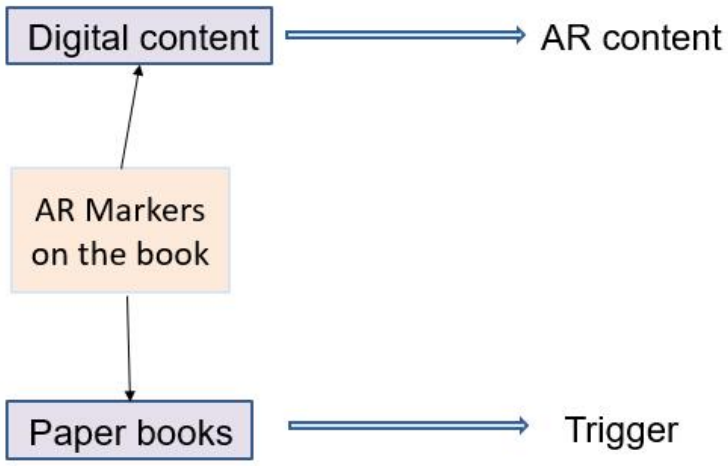


Fig. 4.1 Method to Combine Augmented Reality and Physical Interaction

Fig. 4.1 shows the method to combine augmented reality and physical interaction. In diary writing, digital content has the benefits of digital content, and physical interaction can also bring a good experience. Here we use a physical book with AR markers to combine them together. Then we change the digital content into AR content. And we use the paper book as the trigger to achieve the task.

On the basis of this method, we designed a relatively complete system architecture to enable users to read and write the diary. The architecture is in Fig 4.2.

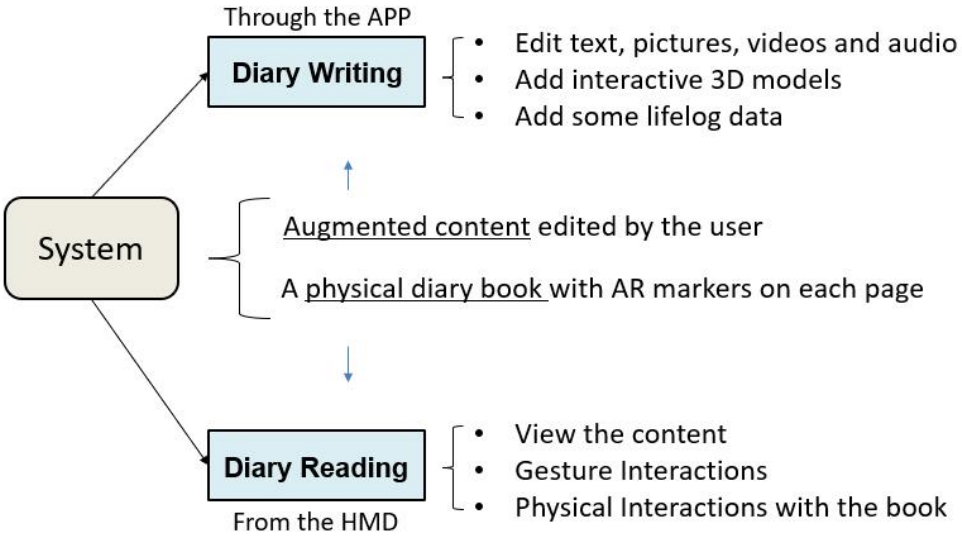


Fig. 4.2 The Architecture of the System

The system mainly has two functions. The first function is the diary writing. The second is the diary reading. With these two functions we can enable users to better read and write diaries.

To help people write the digital diary more conveniently, we implement the diary writing function. The diary writing function is on the smartphone application. It include editing the content, adding 3D models and adding life-log data.

To help people read the diary in AR better, we implement the diary reading function. It is on the HoloLens. Users can view the content they write, do some gesture interactions and do physical interactions with the physical book.

Chapter 5

System Design

This chapter will introduce the design of the system. This chapter includes five parts. The first part is the system design overview part. The rest parts will be divided into diary content design, diary writing function and diary reading function. The final part will introduce the user scenario.

5.1 System Design Overview

This system includes two major functions and three components.

- **Two major functions:**

1. Writing diary function: Users use their smartphone to write the diary. The system supports editing text, adding pictures, videos, audios and models.

2. Reading diary function: The system has a physical book with AR markers. When the content of a page diary is completed, it will be stored and associated with an AR marker. Users can read the contents of the diary with HoloLens, and they can also use gestures to interact with models and video playback.

- **Three components:**

1. Smartphone: The smartphone is used to write the diary. Users edit the digital content, 3D object and life-log data on the smartphone application.

2. AR glasses: This system uses HoloLens as the AR glasses. Users wear the HoloLens to read the diary and do some interactions.

3. Physical book with AR marker: The approach of this research is to combine digital diary content with physical interaction. So the Physical book with AR marker is used to show augmented information and provide the users with physical interactions.

Fig. 5.1 shows the system overview structure.

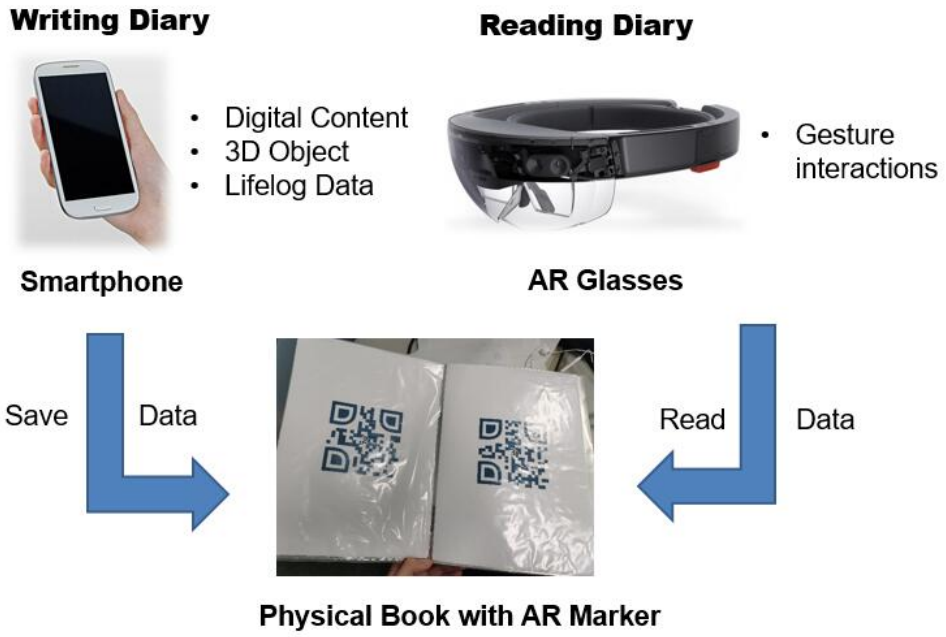


Fig. 5.1 System overview

5.2 Diary Content Design

This part will introduce the design of diary content. There are five types of diary content that users can edit. They are text, pictures, videos, audio and 3D models.

5.2.1 Text Content

The first type of diary content is the text content. Just like writing in a paper diary or typing in an electronic diary, users can enter text on the system's mobile application.

When users want to add the text content, first click the "write" button to enter the writing page. When entering the writing page, users can enter text content. When finishing writing, users need to click "finish" button to exit the writing page.

5.2.2 Picture Content

The second type of diary content is the picture content. The image file on the smartphone can be read by the application and can be added to the diary page.

When users want to add the picture content, first click the "add media" button on the system menu. The system will display the smartphone file path and all files. Users click on the picture file they want to add to add it to the diary page.

Fig. 5.2 shows what the text content and the picture content look like on the smartphone.

Fig. 5.2 Text Content and Picture Content

5.2.3 Video Content

The third type of diary content is the video content. The application can read the video file on the smartphone and can add it to the diary page.

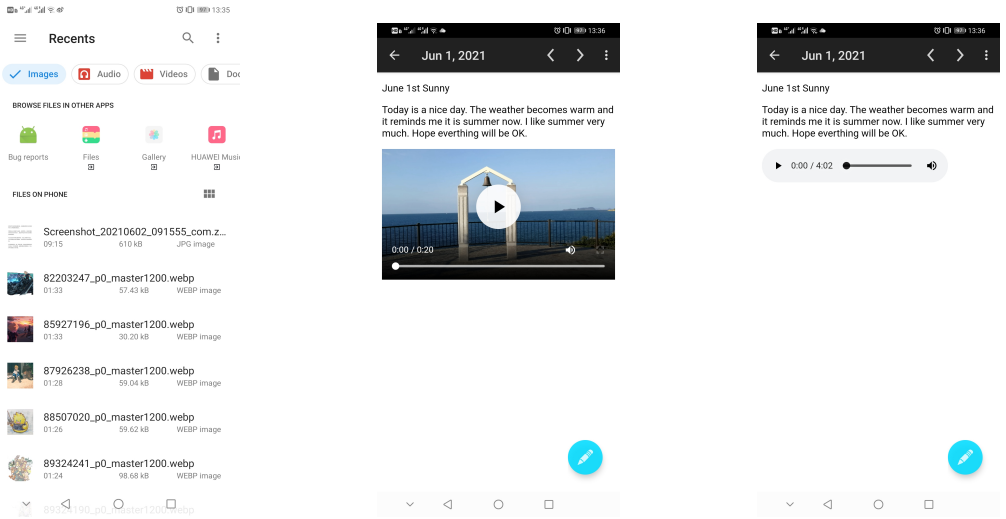
The way to add video files is similar to the way to add pictures. When users want to add the video content, first click the "add media" button on the system menu. The system will display the smartphone file path and all files. Users click on the video file they want to add to add it to the diary page. Then users can click the video to control it to play or pause on the application.

5.2.4 Audio Content

The fourth type of diary content is the audio content. The application can read the audio file on the smartphone and can add it to the diary page.

Users first click the "add media" button on the system menu to enter the file selection page. Then select an audio file to add to the page. After adding, the play button will appear.Users can click the play button to play the audio.

Fig. 5.3 shows the file selection page and what the video content and the audio content look like after being added on the smartphone.



(a) Add Media Page (b) Video Content (c) Audio Content

Fig. 5.3 Adding Video Content and Audio Content

5.2.5 3D Model

In addition to the regular content of the electronic diary, the system also allows users to add 3D models. This makes the users feel more real when using HoloLens to read the diary.There are two kinds of models that users can add. The first is the pre-made model in the system, and the second is the model built by users using photos.

- **Pre-made models**: Users can choose a model from the model list to add to the page. These models are built in advance and stored in the system. The model can be seen when users use the HoloLens to read the page.

- **Models built by users**: Users create their own models with the help of Reality Capture API.The Reality Capture API provides a set of endpoints for the Photo to 3D capability.

These endpoints allow the user to manage the process of generating a 3D mesh from overlapping photos. Users take photos of an item from different angles, and upload these photos to the cloud using the API. The model can be downloaded from the cloud after waiting for a period of time. The effect is like Fig 5.4.

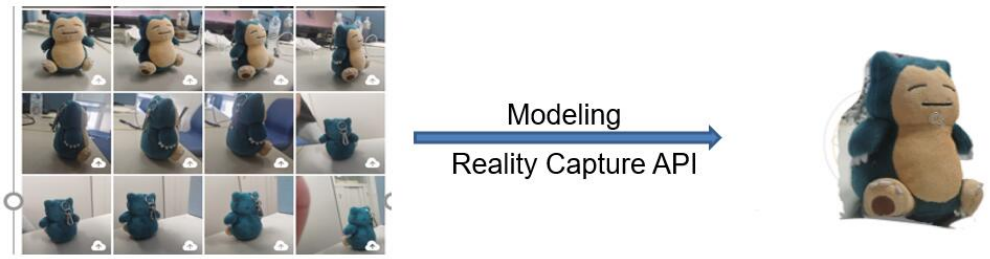


Fig. 5.4 Model Building

5.3 Diary Writing

As mentioned above, the system has two main functions. The first is the diary writing function on the smartphone. The other is the diary reading function on HoloLens. This part will introduce the diary writing function of the system in detail.

Users can do some operations while writing a diary on a smartphone. The main operation is to edit the contents of the diary mentioned above. In addition, users can add life-log data and choose to share diaries with friends.

5.3.1 Edit Diary Content

Editing the contents of the diary is the most important operation. The content of the diary includes text, pictures, video, audio and 3D models. Their information has been detailed in Section 5.2. After entering the system, users can edit the contents of these diaries. The editing method of each content will be different. The method is as mentioned in section 5.2. When finishing writing a diary content, users clicks the "Save" button to save it. After saving, users can bind all the contents of the diary to the next blank AR Marker of the physical book.

In this way, users can use HoloLens to read the diary content. The appearance of a completed diary on the smartphone is shown in the Fig 5.5.

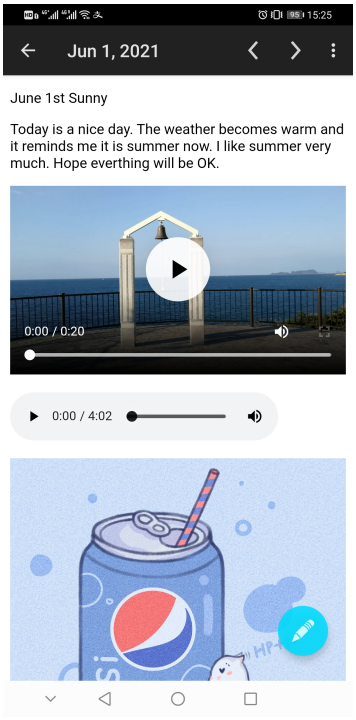


Fig. 5.5 The Appearance on the Smartphone

5.3.2 Add Life-log Data

In addition to regular diary content, people often use some life-log data when writing diaries.

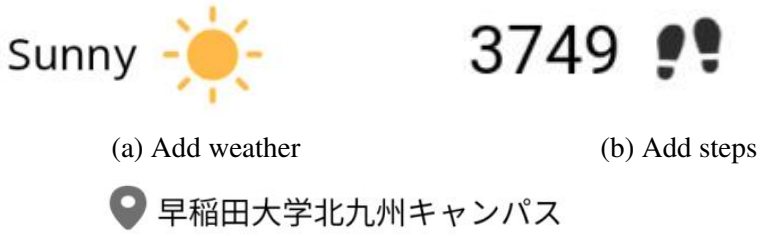
Life-log is a personal record of one's daily life in a varying amount of detail, for a variety of purposes. The record contains a comprehensive data-set of a human's activities. In recent years, mobile devices has been a very useful way to capture the life-log data. So when a user writes a diary, it is a very convenient operation that the system can read some useful life-log data from the smart phone and give it to the user to choose whether to add it to the diary page.

At present, the system provides three kinds of life-log data that can be directly added to the page. They are weather, number of steps and location.

- **Weather:** When writing a diary, many people will fill in the weather of the day. However, it is troublesome to manually fill in the weather every day. So the system provides the function of automatically adding weather. The user only needs to click the "Add Weather" button on the menu, and the system will call the QWeather API and automatically add the day's weather in the first line of the diary.

- **Number of steps:** The number of steps you walk every day is sometimes very memorable, especially for those who exercise and travel. It would make sense if the data could be added to the diary page. Therefore, the system provides the function of automatically adding step information. After the user clicks, it will connect to the step information interface of the smart phone, get the step number and automatically add it to the diary page.

- **Location:** Location information is also a very meaningful information in the diary. People usually write diaries to record their travels and meaningful events. So it would be useful to be able to add location information directly. The system use Google Map API and let users choose the location.



(a) Add weather (b) Add steps

(c) Add location

Fig. 5.6 Adding life-log data

The appearance after adding Life-log data to the page is as shown in the Fig 5.6.

5.3.3 Diary Sharing

When users want to share their own diary with friends, they can use the diary sharing function. This operation supports remote users to read the text and picture content of the diary.

When the user finishes writing a diary, click the "Share Diary" button. After this, the system will generate a QR code picture. Initially, the system will use the Vuforia Web Service (VWS) API to upload the QR code and diary content to the Vuforia cloud and bind them. After that, the user is required to share the QR code with the remote user. The remote user can print it out. When wearing HoloLens and using the system to recognize the QR code, the diary content can be displayed.

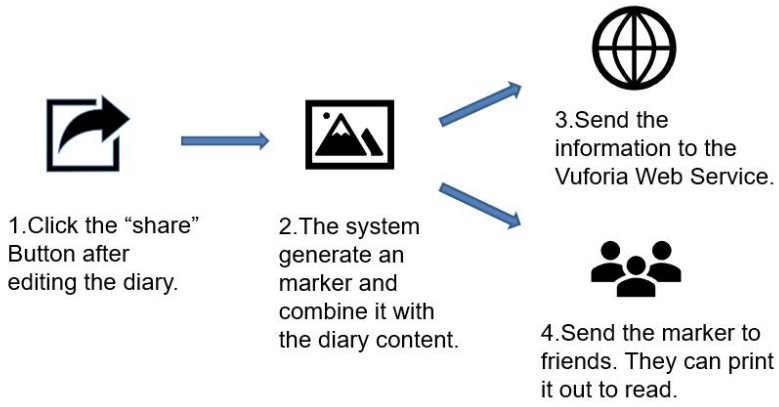


Fig. 5.7 The Flow Chart of the Diary Sharing Function

5.4 Diary Reading

The second main function is the diary reading function on the HoloLens. This part will introduce the diary reading function of the system in detail.

The system will copy the layout of the diary content on the smartphone. And then display the content in the same layout on the HoloLens application. This is the diary showing part. Also, the system provides some gesture interactions, so that users can use gestures to interact with the content of the diary while reading the diary. This section will also introduce how the augmented content is combined with the physical interactions.

5.4.1 Diary Showing

Users can use HoloLens to read the contents of the diary. The content, layout, and interactive 3D model of the diary will be completely restored to the HoloLens application. If users want to display the diary content on HoloLens, they need to deploy all three components.

- **Smartphone application**:First, users need to edit the diary content in the smartphone application, then save and upload it successfully.
- **Physical book with AR markers**: After the diary content in the smartphone is saved and uploaded, it will be bound to the next blank AR marker on the physical book. After binding, use the AR marker as a trigger to display the content.
- **HoloLens**: Finally, users wear the HoloLens to read the diary. The content will be shown when the HoloLens recognize the AR marker on the physical book.

The content of the diary users can see with HoloLens is shown in the Fig 5.8.

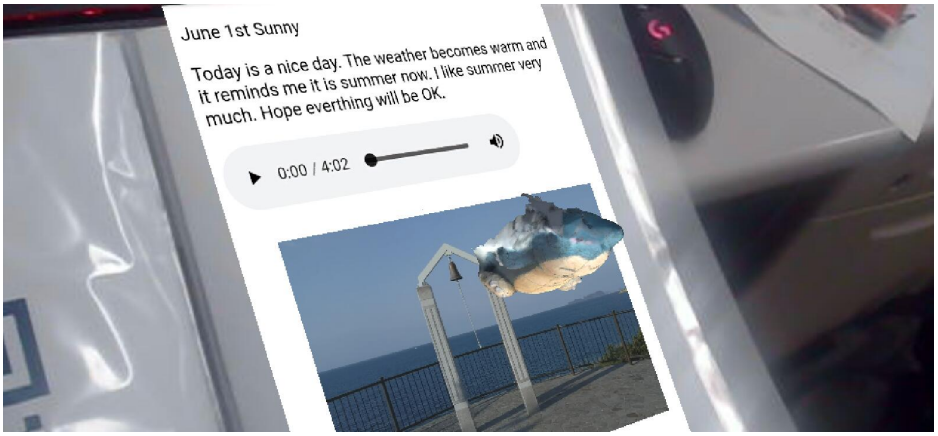


Fig. 5.8 The Diary Content Shown in HoloLens

5.4.2 Gesture Interactions

Since video and audio content are dynamic, the system provides users with some gesture interaction methods to control them. This provides users with a better experience. In addition, users can also use gestures to interact with the 3D model, making the experience of reading the diary more realistic.

- **Interactions with video and audio**:The start and pause of video and audio need to be controlled by users. The user can use the index finger to lightly tap the location of the video and audio to control. If they are paused, users can click to make them play. If they are being played, users can click to pause them.Fig 5.9 shows how to use gestures to control the start and pause of the video.

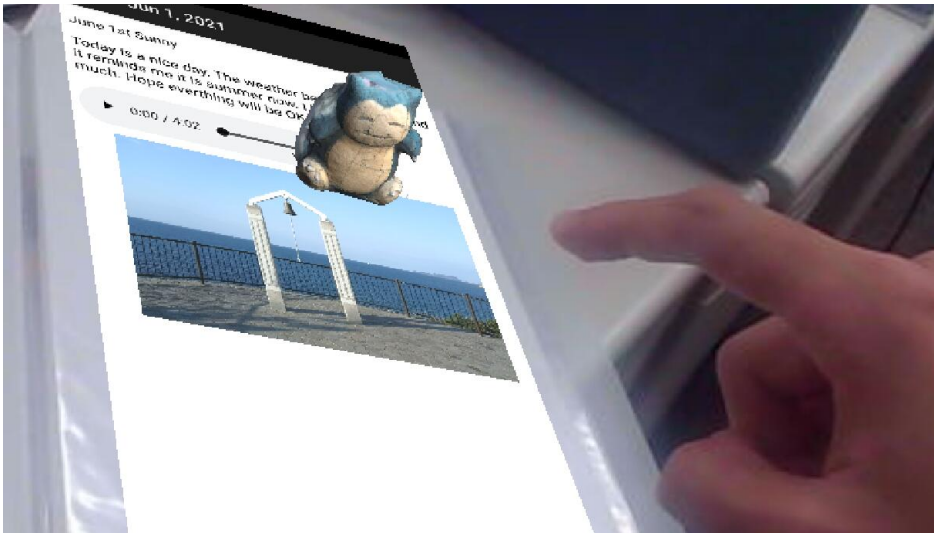


Fig. 5.9 Gesture Interactions with the Video Content

- **Interactions with 3D models**: In addition to dynamic content such as video and audio, users can also interact with 3D models added to the diary page.The interaction with the 3D model includes movement, rotation and scaling.Each interaction corresponds to a different gesture.Fig 5.10 shows the gesture interactions with the 3D models.

(a) Movement (b) Rotation (c) scaling

Fig. 5.10 Gesture interactions with the 3D models

5.4.3 Physical Interactions

If the diary has only digital content, people's reading experience will lack real feeling and comfort. Since most people prefer to read paper books compared to e-books, the system uses a physical book with AR markers to provide physical interactions.

Each page of the physics book is equipped with an AR marker. The AR marker on each page is unique. These markers are placed in the physics book in advance and do not need to be changed by the user.

When the user completes the diary writing in the smartphone application, the system will bind the diary content to the next blank page. At this time, the user only needs to wear HoloLens to read the diary content.

The user can perform some physical interactions with the physical book. Users can turn pages, move, rotate and do other operations while reading, just like reading real paper books.When performing these operations, the displayed augmented content will also change its position following the real physical book to provide a real physical interactive experience.

The physical book with AR markers is shown as Fig. 5.11.

Fig. 5.11 The Physical Book with AR Markers

5.5 User Scenario

This part introduces how will the users use the system. The activity diagram of the system is shown in Fig. 5.12.

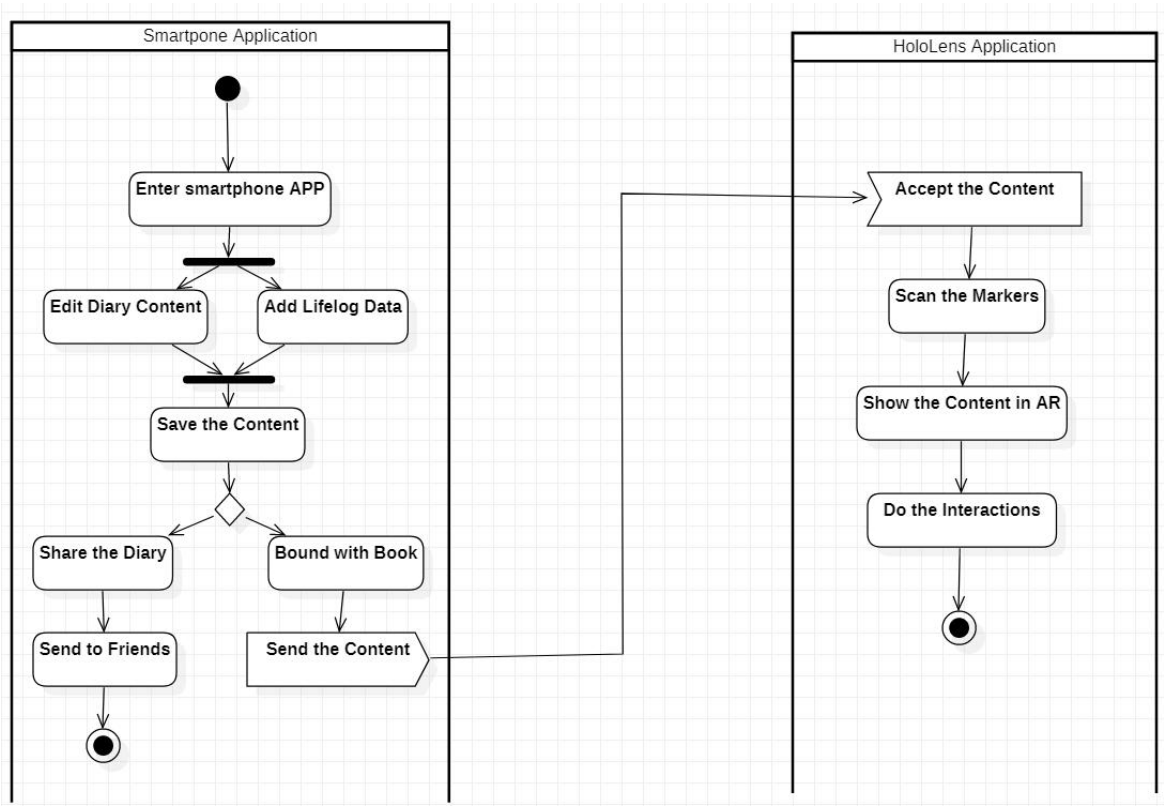


Fig. 5.12 The Activity Diagram of the System

As shown in the system activity diagram, the system has two applications that require user operations in addition to a physical book. One is the smartphone application and another one is the HoloLens application.

- **Smartphone Application:**

When users want to use the system, they need to open and enter the application on the smartphone. When the system starts running, users can edit the contents of the diary and add life-log data.

After the user finishes editing and saving the content, there are two options. The first is to share the contents of the diary with remote friends. At this time, the system will upload

the contents of the diary to Vuforia Cloud, so an Internet connection is required. The user can send the generated QR code to a friend to let he read the diary on his system. The second option is to read it by the user himself. At this time, the system will bind the content to the next empty AR marker of the book, and send the content to the local server for transmission to complete the operation on the mobile phone.

- **HoloLens Application:**

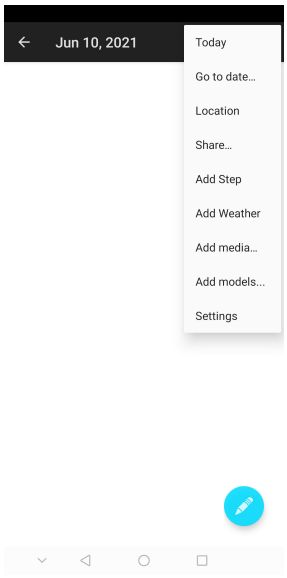
When the user wants to read the diary content by himself and completes the smartphone operation, he can use the HoloLens application to read the diary content.

When the HoloLens application receives the content sent by the mobile phone, it will create an AR object in the system and restore the original layout. When the user scans the corresponding AR marker with HoloLens, the corresponding AR content will be displayed.

Then the user can do some interactions, including some gesture interactions with the diary content and physical interactions with the physical book.

- **Story:**

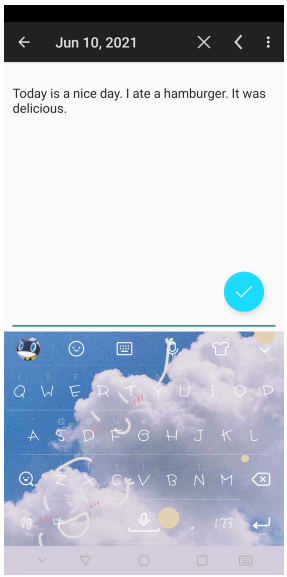
For example, today is June 10th, and the user wants to write a diary to record his life today. First he will open the application on the smartphone. He click "Add Weather" and "Add Step" button to add the life-log data at first lines. Fig. 5.13 shows the steps to add the life-log data. (a) shows the options in the menu. (b) shows what will the diary look like after adding the data.

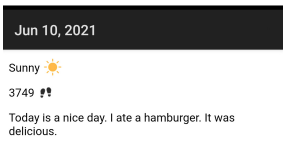


(a) Options in the Menu (b) The Life-log Data Added to the page

Fig. 5.13 Steps to Add the Life-log Data

Then he clicks the "Write" button in the lower right corner. When entering the text editing mode, he writes the text as "Today is a nice day. I ate a hamburger. It was delicious". Fig 5.14 shows the steps to add the text content. (a) shows the user interface of the text editing page and (b) shows the diary page after editing the text.

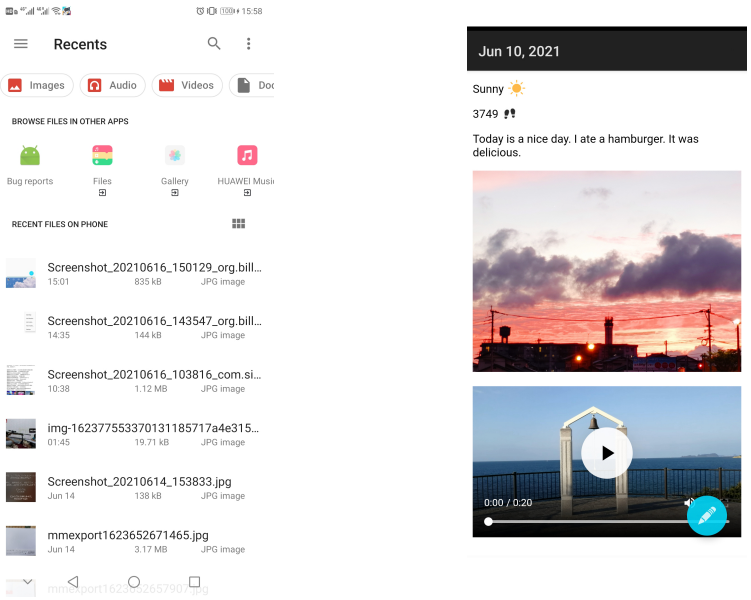




(a) The Text Editing Page (b) The Text Content Added to the page

Fig. 5.14 Steps to Add the Text Content

Also, he clicks "Add Media" button to enter the file selection page. In the file selection page, he chooses a picture of the sky and a video of the sea he took today to add to the page. Fig. 5.15 shows the steps to add the picture content and the video content. (a) is the file selection page and (b) shows the diary page the picture content and the video content is added.



(a) The File Selection Page (b) The Picture and Video Content

Fig. 5.15 Steps to Add the Picture and Video Content

Finally he clicks "Add Model" to enter the file selection page add a hamburger model from the preset list to the page. After he clicks "Save" button to save and upload the diary, the system binds the diary to the AR Marker on the next empty page. Then he wears the HoloLens, and turn to the page to read the diary. The effect seen with HoloLens is shown in Fig.5.16. He can do some gesture interactions with the model and the video.

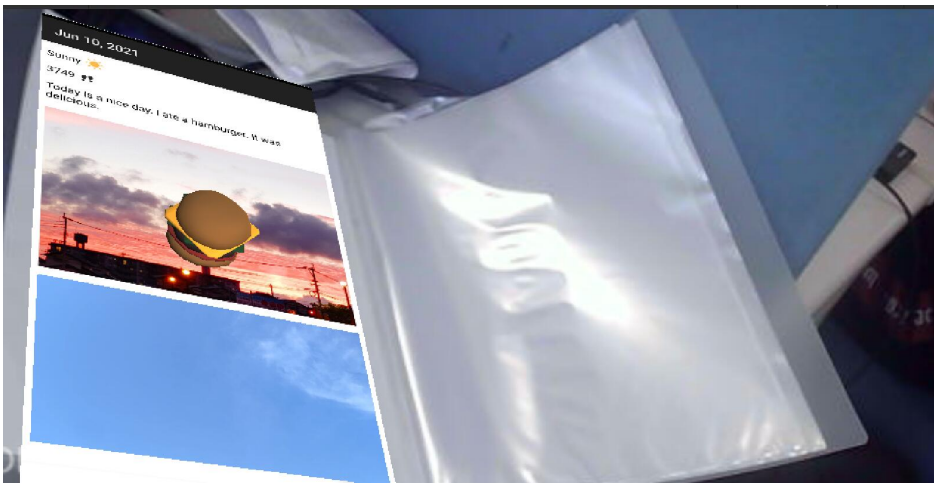


Fig. 5.16 The User's View When Reading the Diary

Chapter 6

System Implementation

6.1 System Hardware

In order to allow users to free their hands for some gestures and physical interactions, the system uses a mixed reality HMD device instead of a mobile phone as a device for displaying the augmented content.

This system uses Microsoft HoloLens 2 as the mixed reality HMD device. It can be used to recognize the AR marker, display the augmented diary content and recognize the user's gestures. Fig. 6.1 is the HoloLens device we use in the research.

Fig. 6.1 HoloLens Device

We use an Android smartphone to write the diary and send data. It is the second hardware in the system. It will upload the files and modify the database on the server. Here we use Huawei Mate 30 e Pro for test. Fig. 6.2 is the smartphone we use.

Fig. 6.2 Huawei Mate 30 e Pro

In addition to the above two hardware devices provided to users, the system also needs a laptop PC to transfer data as a server. We connect the smartphone, the laptop PC and the HoloLens to the same local area network for data transmission between each other. We use Fig.6.3 and Table 6.1 show the information of the PC we use.

Fig. 6.3 Laptop PC

Operation System	Windows10
CPU	Intel(R) Core(TM) i5-9300H CPU @ 2.40GHz
Graphics Card	NVIDIA GeForce GTX 1660 Ti
RAM	8.00GB

Table 6.1 The PC Setup Information

6.2 Software Environment

The Software Environment support is:

1. Unity 2019.4.23f1c1, it provides the development platform for applications based on Universal Windows Platform (UWP) which can be run on HoloLens. Unity is also implemented with an XR SDK which helps the system in AR experience.

2. Mixed Reality Toolkit 2.3.0 (MRTK v2), it supports basic hand poses, interface UXs and some basic configuration modules for our mixed reality system.

3. Vuforia 9-8-8, it is a software development kit (SDK) for creating Augmented Reality apps. Developers can easily add advanced computer vision functionality to any application, allowing it to recognize images and objects, and interact with spaces in the real world. [25]

4. Android Studio, which is an Android integrated development tool launched by Google, based on IntelliJ IDEA. Similar to Eclipse ADT, Android Studio provides integrated Android development tools for development and debugging.[26]

5. Wampserver, it is a Windows web development environment. It allows users to create web applications with Apache2, PHP and a MySQL database.[27]

6. QWeather API which provides an interface to query the current city weather.[28]

Besides, we used Visual Studio 2019 with C# for scripting, debugging and simulation.

6.3 Data Transmission

Since the system is composed of three parts of hardware devices, how to transfer data between these hardware devices is the key point of system Implementation. The data transmission method of reading a diary by the user himself and sharing a diary with a friend is different.

6.3.1 Reading by the User Himself

When the diary is completed, data needs to be sent from the phone to the HoloLens application. In the system, we use a laptop computer as a local server to achieve this sending process.

After the user completes the content of the diary on the mobile phone, the system saves the text and picture content of the diary as a complete picture, and sends the picture, video, audio, and model files to the local server through HTTP requests.

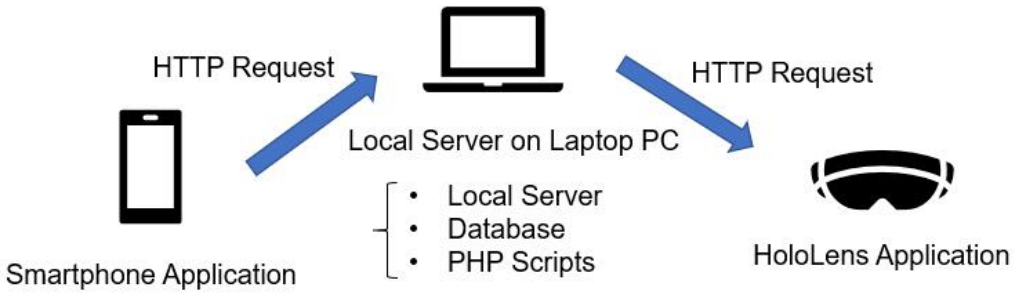


Fig. 6.4 Data Transmission Process

In addition to these files themselves to be transferred, their ID, type, location and content url will also be saved, so that the layout of these diary content can be restored using AR on HoloLens. The WampServer on the laptop PC has a server, a database and PHP scripts to receive data from the smartphone and store the relevant data in the database. The smartphone will send a request to call the PHP scripts in the server to operate the database. The data in the database is shown in Fig. 6.3.

#	Name	Type	Collation	Attributes	Null	Default
1	content_id	int(10)			No	None
2	content_type	int(10)			No	None
3	content_position	int(11)			No	None
4	content_url	varchar(100)	latin1_swedish_ci		No	None

Fig. 6.5 Database Design

- content_id: A unique number used to identify content.
- content_type: Since video files and audio files are dynamically interactive, their location and url are needed to restore the original layout. content type is used to identify whether the file is a video file or an audio file, 0 represents a video file, and 1 represents an audio file.
- content_position: Percentage from the top of the page. For example, if the video or the audio is on the top of the page, it will be 0. If the content is at the center of the page, it will be 50.
- content_url: the file path of the video or the audio on the server.

After the files are uploaded and the database information is modified, users can wear HoloLens and use the system to read them. The HoloLens application is built using Unity. The HoloLens will use Unity Web Request to download the files on the server and call the PHP scripts to read the data from the database. Then it will use the scripts to bind the content with AR markers. In order to restore the layout, each content has a different binding method.

- Text and Picture content: They will be saved as a picture. The picture will be bound to the AR marker with a fixed size.
- 3D Model: It will be directly bound to the AR marker and placed in the center of the AR marker.

- Video content: The system will use the C# script to create a plane and a video player component on the plane. The position is calculated by the content position data in the database. And the system will set the url attribute of the video player to the url data read in the database. Then the system will create a virtual button to control the play of the video.

- Audio content: The system will use the C# script to create a audio source component based on the position data in the database. And it will set the audioclip attribute to the url data in the database.

6.3.2 Sharing with friends

Since the local server can only transmit data under the same local area network, if the user wants to share with friends far away, the system needs another server.

Then we use the Vuforia Cloud Recognition function to realize it. When the user wants to share his diary with his friends, he can click the "Sharing" button. Then the system will call the Vuforia Web Service(VWS) API to upload the image target and the content to the Vuforia Cloud. Since realizing the interactions and determine location of the video and the audio will be difficult in the sharing part without the local server, now the system just support the text, picture content and the 3D model.

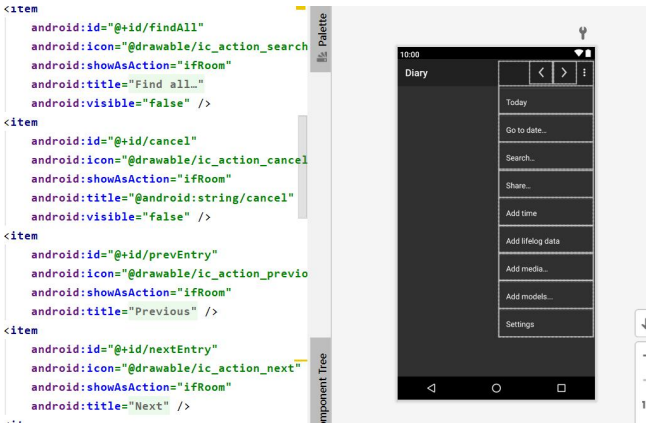
After completing the above steps, the user can send the picture of the image target to a friend. The friend can print it out and use the HoloLens to read it directly.

6.4 Smartphone Application

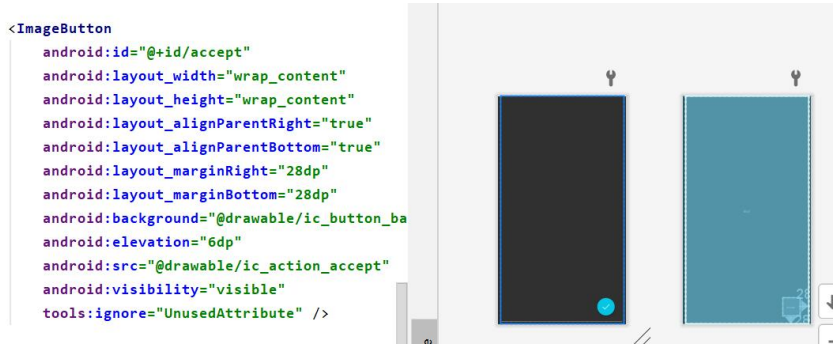
We use Android Studio to develop the smartphone application. In Android Studio, we use Java statements to implement some logic functions, and then use XML to implement the user interface.

6.4.1 User Interface Implementation

The realization of the user interface is realized by relying on the xml statement. In this system, the interface mainly includes the main interface, editing interface and menu interface. The main interface is the background page that the user sees when entering the system. The editing interface is the interface entered when the user edits the text content. The menu interface is at the top of the main interface, providing different function options for users to choose.



(a) Menu Interface



(b) Main Interface

Fig. 6.6 The XML Statement and Interface Design

The XML statement of the UI design of the menu interface and the main interface is shown in Fig. 6.6.

6.4.2 Logic Function Implementation

The realization of the logic function is executed by the Java statement. The logic function of the system includes all the functions related to diary writing mentioned in section 5.3 of this article.

In the life-log adding function, some API are used to implement these functions. As for the weather, we use QWeather API to query the weather of the current city and add the returned data to the page. As for the location, we use Google Map API to determine a location on the map and add it to the page. Finally, we realize the connection between the functions and the jump between the pages to complete this part.

6.5 HoloLens Application

We use Unity3D to develop the HoloLens application. In Unity3D, we use C# scripts to control the objects. As for the Mixed Reality part, we use the Vuforia Engine and the Microsoft's Mixed Reality Toolkit as implementation tools.

6.5.1 Object Creation

All diary contents are created as objects in Unity. In the Unity Scene, the ImageTargets are the image target used for recognition in Vuforia. In this system, they are the AR Markers at the position of (0,0,0).

- The static content, such as the text and the picture content, will be saved as a picture. The texture type of the content picture will be set to Sprite (2D and UI) and the position will be set to (0, 0, 0). The rotation will be set to (90 ,0, 0) and the scale will be set to (0.15, 0.15, 0.15). Then it will be placed under the ImageTarget in the hierarchy to bind with the AR Markers.

- 3D model is another static content, the size of the preset models is decided in advanced. It will be created at the position of (0, 0, 0) directly.
- The creation of the dynamic content, such as the video content and the audio content is based on the database data read from the local server to restore the diary layout. As for the video content, the system will use C# scripts to create plane at the position read from the database. Then the system will create a video player component on the plane, and set the url attribute of the video player to the url read from the local server database. The audio content is similar. The system will create the audio source component at the position read from the database and set the audio clip attribute to the url read from the local server database.

The relationship between them is shown in Table 6.2. The scene in Unity editor and the hierarchy of the objects are shown in Fig 6.7

Content Type	**Object in Unity**	**Position**
Text Content	Picture (Sprite)	(0, 0, 0)
Picture Content	Picture (Sprite)	(0, 0, 0)
3D Model	Object(obj file)	(0, 0, 0)
Video Content	Plane(Video Player)	From database
Audio Content	Audio Source	From database

Table 6.2 The Method to Create Objects in Unity

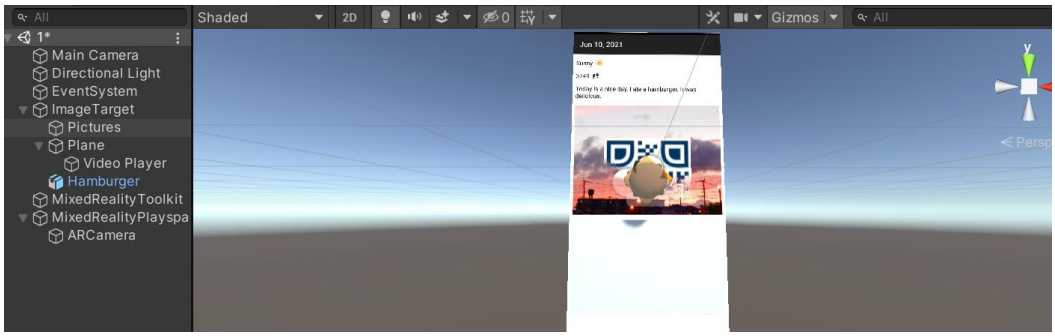


Fig. 6.7 The Scene in Unity and the Hierarchy

6.5.2 Gesture Interaction

Gesture interaction is implemented in Unity. As mentioned in Section 5.4, the system has two gesture interactions. One is the interaction with video/audio, and the other is the interaction with the 3D model.

- As for the video and the audio content, the system will create a Object Manipulator script on the video player component and the audio source component. We modify the script to change the event to the play or pause function of the video player component and the audio source component.When users click the component the event will be triggered. Fig 6.8 shows the script and the event to achieve the function.

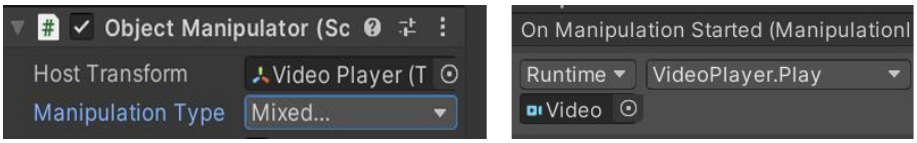


Fig. 6.8 The Script to Control the Video/Audio

- As for the 3D model, the system use the camera of the HoloLens and the function provided by MRTK API to realize the gesture interactions with the 3D models. We modify the script to achieve this function.Fig 6.9 shows the script to achieve the gesture interactions.

Fig. 6.9 The Script to Control the Video/Audio

6.6 Physical Interaction

In the system, we use a physical book with AR markers to implement the physical interaction. Every page of the physics book has an AR maker. They are prepared in advance and placed in order. Therefore, users only need to read and interact with the diary content after wearing the HoloLens after completing the preparations for the smartphone and HoloLens application.

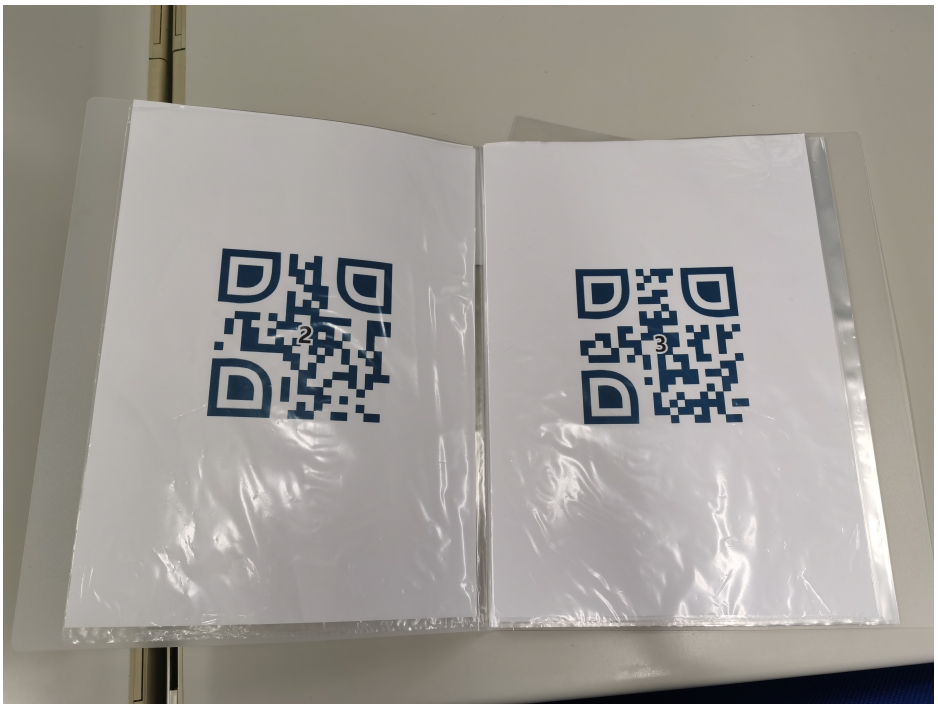


Fig. 6.10 The Physical Book With AR Markers

Fig 6.10 shows the physical book with AR markers. With the implementation of the book, users can do physical interactions with the book, such as turning the pages and moving the book, just like reading a real paper book.

Chapter 7

Conclusion and Future Work

7.1 Conclusion

In this research, we proposed a diary writing and reading system with augmented content and physical interactions. In order to allow users to better write diaries and use augmented reality to interact with diaries, we designed and implemented a three-part system of mobile phone applications, HoloLens applications and physical books.

First, we design the content types that can be edited by the users and the interaction methods of each of them. The content type includes text, pictures, video, audio and 3D models. We implement a physical book with AR markers to achieve the physical interactions and use it as a trigger to read the augmented content.

Then we design and implement the interaction methods of writing the diary. We design the function to edit the content and apply life-log data from mobile phone directly to writing. Then we design a diary sharing function to let users share their diaries with friends. After designing the interaction methods, we implement a smartphone application to achieve these functions.

Finally, we design and implement the interaction methods of reading the diary. We design the gesture interaction methods with the diary content, which include the interactions with the media content and the interactions with the 3D models. After designing the interaction methods, we implement a HoloLens application to achieve these functions.

7.2 Future Work

In the future, we plan to improve our diary writing and reading system. We will design and add more interactions of writing and reading. We will also improve the visual effect when reading diaries on HoloLens. Furthermore, we will keep doing evaluations to compare the user experience of our system with other similar augmented reality systems.

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